1. Introduction

A growing world wide concern for the conservation of energy has reawakened interest in ecologically sustainable materials, processes and sources of energy.

Solar photovoltaic is one such system which is highly consistent and reliable through out the year which is ideally suited for supplying power at remote locations.

GAIL has good experience of one such solar photovoltaic system installed at their one of the stations and hence wishes to expand use of solar in their other stations as well. Similarly it also wishes to establish similar systems to strengthen the existing stations operation as well.

With this objective, **GAIL** is proposing to set up environmental friendly Solar Power Systems for Compressor stations as a mode for back-up supply thereby reducing use of DG and/or do away with DG sets. The performance of this location shall be monitored closely with special emphasis on maintenance, battery life, reliability etc.

With this background two types of Solar PV Systems are proposed.

2. Design Basis

Solar PV Power plants shall be designed considering the following:

1. Sun shine: 5 Peak hours
2. Existing Battery bank should be considered while designing the system.
3. System voltage : 24V dc (nominal)

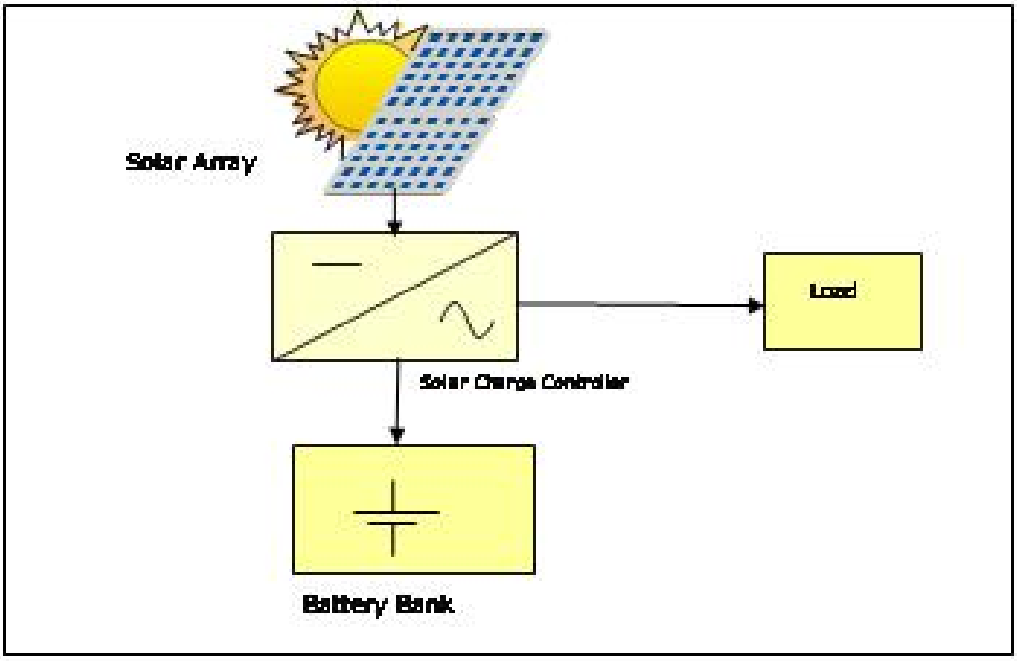
3. Scope of Work

This job involves by means of the enclosed specification, design, manufacture, supply, installation, commissioning of the Solar PV Power System with 1 year warranty period.

The Scope of Work shall include the following,

a. Design, manufacture, supply of Solar PV Power Plant
b. Detailed planning of smooth execution of the project
c. Performance testing of the complete system & warranty of the system for 1 year faultless operation.
d. After-sales service, directly or through local contractual arrangement
e. Risk liability of all personnel associated with the implementation realization of the project.

4. Operation of the system



The Proposed schematic of the Solar PV Power System is shown above. Solar Photovoltaic array produces DC electricity directly from the sun light. The Battery Bank is charged by Solar Array. The charging of Battery Bank is controlled by Solar Charge Controller to prevent excessive discharge or overcharge.

Interconnecting cables are used between various components such as Solar Modules, Junction Boxes, Charge Controller and Battery Bank.

5.0 Technical specifications of major components of Solar PV Power System

1	Solar PV modules and array
2	Module mounting structures for Solar PV Modules
3	Junction Boxes
4	Solar Charge Controller
5	Distribution Boards
6	Cables and installation accessories
7	Earthing and lightning protection
8	Battery & control room– Existing at both locations **(Ref page 7)**

Solar PV modules and array

Crystalline high power cells shall be used in the Solar Photovoltaic module. Each Solar module shall consist of 72 Photovoltaic cells redundantly interconnected **and peak power rating shall not be less than 165 W**. The bidder offering single module with highest wattage shall be given preference.

To connect the solar module interconnection cable shall be provided. Photo / electrical conversion efficiency of **SPV module shall be greater than 13.5%.** Module shall be made of high transmissivity glass front surface giving high encapsulation gain and hot butyl rubber edge sealant for module protection and mechanical support.

All materials used shall have a proven history of reliable and stable operation in external applications. **It shall perform satisfactorily in relative humidity up to 100% with temperatures between -10 Deg C and +85 Deg C and with stand gust up to 200km/h from back side of the panel.**

Solar module shall be crystalline type, employing lamination technology using established polymer (EVA) and Tedlar or Polyester laminate.

Offered modules must be **IEC 61215 certified and IEC 61730 certified**. The offered modules shall be UL and CE certified and also FM approved for Class 1 Division 2 Group A, B C & D Hazardous locations, considering the proximity towards inflammable Oil and Gas environment. The bidder shall submit appropriate certificates.

<u>Other general requirements of PV module</u>

- The rated output power of any supplied module shall not vary more than 3-5% from the average power rating of all modules.
- Higher efficiency cells and modules are preferred. Cell level efficiency shall be over 14.5% and Module Efficiency shall be min 13.5%. Bidder has to prove and provide the calculations for the module level efficiency when called for along with details.
- The module frame is made of corrosion resistant materials, which is electrolytically compatible with the structural material used for mounting the module.
- Protective devices against surges at the PV module shall be provided, if required. Low voltage drop bypass and / or blocking diode(s) may also be provided, if required.
- Module Junction box (weather resistant) shall be designed for long life out door operation in harsh environment.
- **A minimum Power Warranty of 25 years shall be given with degradation of power generated not exceeding 20% over the entire 25 year period (and 5 years limited warranty of material and workmanship).**

- The solar modules shall have suitable encapsulation and sealing arrangements to protect the silicon cells from the environment. The arrangement and the material of encapsulation shall be compatible with the thermal expansion properties of the Silicon cells and the module framing arrangement/material. The encapsulation arrangement shall ensure complete moisture proofing for the entire life of the solar modules.
- Each module shall have low iron tempered glass front for strength and superior light transmission. It shall also have tough multi layered polymer back sheet for environment protection against moisture and provide high voltage electrical insulation.
- The fill factor of modules shall not be less than 0.70 (typical)
- Array capacity shall be suitable to the requirement and calculations should be provided by the bidder. Depending on size of the power plant, number of modules required shall be worked out accordingly.
- Data sheet of the offered module shall be submitted along with the offer giving details of peak power, peak current, short circuit current, fill factor, open circuit voltage, peak power voltage etc.

Orientation and Tilt of PV Module

Modules alignment and tilt angle shall be calculated to provide the maximum annual energy output. This shall be decided based on the location of array installation.

Module mounting structure

- The array structure shall be made of hot dip galvanized MS angles of size not less than 50 mm x 50 mm x 6 mm size. The minimum thickness of galvanization shall be at least 70 microns. All nuts & bolts shall be made of very good quality stainless steel. The minimum clearance of the lowest part of the module structure and the developed ground level shall not be less than 500 mm. The structure shall have tilt span of 0 to 60 deg in steps of 5 deg.
- Leg assembly of module mounting structure made of different diameter galvanized tubes may be accepted. The work should be completed with supply, fitting fixing of clamps, saddles, nut & bolts etc. While quoting the rate, the bidder may mention the design & type of structure offered. All nuts & bolts shall be made of very good quality stainless steel.
- The structure shall be designed to allow easy replacement of any module and shall be in line with site requirements.
- The structure shall be designed for simple mechanical and electrical installation. It shall support SPV modules at a given orientation, absorb and transfer the mechanical loads to the ground properly. There shall be no requirement of welding or complex machinery at site.

- The array structure shall be so designed that it will occupy minimum space without sacrificing the output from SPV panels at the same time it will **withstand wind speed up to maximum 200 km/h. Also it must be compatible for installations in the corrosive atmospheric conditions of coastal locations**
- The supplier/manufacturer shall specify installation details of the PV modules and the support structures with appropriate diagrams and drawings.
- The drawings along with detailed design shall be submitted to GAIL for approval before starting the execution work. The work will be carried out as per designs approved by GAIL.
- PCC Array Foundation Base: The legs of the structures made with GI angles will be fixed and grouted in the PCC foundation columns made with 1:2:4 cement concrete. The minimum clearance of the lowest part of any module structure shall not be less 500 mm from ground level. While making foundation design, due consideration shall be given to weight of module assembly, maximum wind speed of 200 km/hr and seismic factors for the site.
- The bidder can visit the site before quoting rate for civil works. After taking into consideration all aspects of the site, condition of soil etc., the bidder shall quote for civil works. No extra claim shall be entertained at post project stage. The foundation design of module structure design shall be submitted to GAIL for approval. The work will be carried out as per designs approved by GAIL.

Junction Boxes

The junction boxes shall be flame proof & explosion proof. Also dust, vermin and waterproof and made of suitable material. The terminals shall be connected to copper bus bar arrangement of proper sizes. The junction boxes shall have suitable cable entry points fitted with cable glands of appropriate sizes for both incoming and out going cables. Suitable markings shall be provided on the bus bar for easy identification and cable ferrules shall be fitted at the cable termination points for identification. The junction boxes shall have suitable arrangement for the following:

- Combine groups of modules into independent charging sub-arrays that shall be wired to the SCR.
- Provide a test point for each sub-group for quick fault location.
- To provide group array isolation.
- The rating of the JB’s shall be suitable with adequate safety factor to inter connect the Solar PV array.

Solar Charge Regulator (SCR)

SCR shall have Protection against transient / surge.

SCR shall have Blocking diode to prevent discharge of battery through solar array during night.

SCR shall have Protection against Over Charging of the battery.

SCR shall disconnect the Load & Protects the battery against Deep Discharge.

MCBs shall be provided for Array and load.

Built-in cable drop and temperature compensation.

Robust Enclosure.

BATTERY BANK

The existing battery bank available at the station of GAIL will be used in this system. The batteries available are of Ni-Cd cells. However System integration will be in the supplier's scope.

DC Distribution Board (DCDB)

Solar array side breaker and battery side breaker shall be housed in enclosure.

Cables and Accessories

All the cables shall be supplied conforming to IS 1554 / 694 Part 1 of 1988 & shall be of 650 V/ 1.1 kV grade as per requirement. Only polyethylene copper cables shall be used. The size of the cables between array interconnections, array to junction boxes, junction boxes to PCU etc shall be so selected to keep the voltage drop and losses to the minimum. Suitable length of armored cables of appropriate grades shall be provided wherever needed.

The bidder shall supply installation accessories, which are required to install and successfully commission the power plant.

Earthing and lightning protection

Earthing: The array structure of the PV yard shall be grounded properly using adequate number of earthing kits. All metal casing / shielding of the plant shall be thoroughly grounded to ensure safety of the power plant.

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Lightning: The SPV Power Plant shall be provided with lightning & over voltage protection. The main aim in this protection shall be to reduce the over voltage to a tolerable value before it reaches the PV or other sub system components. The source of over voltage can be lightning, atmosphere disturbances etc.

Metal oxide variastors shall be provided inside the Array Junction Boxes. In addition suitable MOV's also shall be provided in the Inverter to protect the inverter from over voltage.

6. Battery room and control room

The bidder shall design suitably the space of the equipment / components to be installed indoor within the existing Control room & Battery Room. The bidder shall submit the detailed drawings of layout etc prior to start of work for approval of GAIL.

7. Bill of Materials

A complete Bill of Materials inclusive of Solar PV Modules, array Junction box, main junction box, cables, Battery bank, Solar charger, Array mounting structures etc shall be provided along with the offer. The numbers of each component proposed for supply shall be clearly specified. The items not listed in BOM but required for successful installation/commissioning of power plants shall also be added, as required.

8. Spare parts

Bidder shall keep stock of essential spares at their nearest service center and/or for 1 year of warranty. However bidder shall list out spare parts required for power plant. GAIL shall buy essential spares after the warranty period.

9. Installation and commissioning

- **The bidder is advised to visit the site before quotation. The site is approx 100 KM from Mumbai and 150km from Pune. The site is in remote location and our company shall not be in a position to provide electricity, water or manpower .The work at the site shall be carried out through permit system. Only authorized person can work at site in presence of GAIL representative. The worker inside the premises has to obey safety procedure.**
- The bidder is responsible for arranging all the accessories and measuring instruments required to smoothly commission the power plants.

- The plant shall be commissioned in the presence of GAIL authorized personnel or its nominated representative.
- An acceptance report shall be prepared and signed by all participating parties.

10. Packing, shipping and marking

The bidder shall be responsible for assuring that all commodities shipped are properly packed and protected to prevent damage or deterioration during shipment. Packaging and shipping costs shall be borne by the supplier. Customs clearance and all costs and actions associated with import duties, taxes and processing of documents within India are borne by the bidder.

11. Insurance

The bidder shall provide insurance coverage ex-factory until commissioning, and acceptance for replacement or repair of any part of the consignment due to damage or loss.

12. After sales & service

The bidder shall give the details of their service center in the state of Maharashtra (close to Panvel / Mumbai / Pune) and ensure that essential men and materials are placed to ensure quick and efficient after sales service.

Training and after sales service is an important component of supply. The terms and conditions for training and after sales supply and service are to be presented clearly in the proposal and the extent and duration of after sales support clearly defined. An explanation of preventative maintenance schedule, plan of operation, scope and implementation of the after sales service is to be defined.

13. Health, Safety & Environment

The successful bidder shall submit the following before starting the installation of the power plant.

- Safety and Environment policy of the Company
- Emergency Management Plan

14. Delivery of the power plants

The total delivery period shall be 10 weeks from the date of placement of PO. This includes submission & approval of drawings also.

15. Documentation

Two sets of installation manual / user manual shall be supplied along with the each power plant. The manual shall include complete system details such as

array lay out, schematic of the system, inverter details, working principle etc. Step by step maintenance and trouble shooting procedures shall be given in the manuals.

16 Technical Evaluations

The bidder must clear submit bill of material as 5.10kw (ONE no) as independent units and must comply with the following otherwise those party shall be deemed as technically rejected. At any point of time these technical documents required for evaluation the document sent by E-Mail shall not be considered for evaluation.

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- Each Solar module shall consist of 72 Photovoltaic cells redundantly interconnected and peak power rating shall not be less than 165 W. Bidders must submit only manufacture's catalogue/datasheet to prove the same. No other documents shall be acceptable for the same.
- The bidders must mention the model of PV module very clearly in bill of material and it(the module) must be clearly mentioned in the certificates of IEC 61215 & IEC 61730 certified to be submitted . The bidder shall submit appropriate certificates. Also should have the approval for hazardous condition (FM – Class 1 Division 2 – Group A, B, C & D hazardous locations), & UL std. approval for electrical fire & safety (class c fire rating) .

- The Bidder must have ISO 14001 Certification for the facility from where the SPV cells and modules are manufactured.
- Manufacturing datasheet/catalogue shall be attached showing that particular module shall have minimum 12 Year limited power warranty for 90% power Output & 25 Year limited warranty for 80% power output. Also limited warranty of 5 years against workmanship and material.

- A complete Bill of Materials inclusive of Solar PV Modules, array Junction box, main junction box, cables, Battery bank, Solar charger, Array mounting structures etc shall be provided along with the offer. Offers not providing the same shall not be evaluated
- Offers not providing minimum array capacity of designated rating (Wp) shall be considered non-responsive and shall not be evaluated.
- The bidder must mention the provision of sensors & signal conditioning of various signals as mentioned below with proportional outputs :-

- Battery voltage

- PV voltage

- PV Current

- Battery Current

- Charger Temperature Sensing

- Battery Temperature Sensing

- Remote Alarm facility for various signals

- Energy Monitoring system : Various parameter monitoring & logging system for Battery Ah, PV AH, Battery Volts, PV volts, Temperature, KWhr – day basis & history data

- Adjustable Setting of Battery charging algorithm.

- Remote Display facility provision.

- Battery, PV & Load Isolators

- Temp. Controlled forced cooling.

Bidders not providing the data showing above monitoring/Sensor system along with the offer shall be technically rejected.